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ABSTRACT

A frequent criticism of education in the United States today is that teachers are not challenging and teaching students to think beyond the simple task of recalling information. In response to this criticism, during the school year of 1986-1987, the Delaware Department of Public Instruction and local school districts provided a staff development program in the elements of effective instruction to every teacher, specialist, and building-level administrator. The department also established a task force which recommended a state-wide development program for enhancing higher order thinking for all students, at all grade levels, and in all content areas. This training module is part of that program. Objectives stipulate that by the end of the workshop participants will: (1) know the steps in creative problem solving; (2) participate in brainstorming and SCAMPER (Substitute, Combine, Adapt, Modify, Put to other uses, Eliminate/Elaborate, Reverse/Rearrange), two idea finding techniques used in problem solving and decision making; and (3) be able to identify teacher behaviors that promote problem solving/decision making and those that hinder it. Materials contained in the packet are a series of handouts and transparencies related to the objectives for use in the workshop sessions. (LL)

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HIGHER ORDER THINKING

"Problem Solving/Decision Making"

A Module for Staff Development

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July, 1989

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FOREWORD

A frequent criticism of education in the United States today is that teachers are not challenging and teaching students to think beyond the simple task of recalling information. To respond to such criticism and to improve the overall effectiveness of teaching in the state, during the 1986-87 school year, the Delaware Department of Public Instruction and local school districts provided a staff development program in the elements of effective instruction to every teacher, specialist, and building-level administrator. At the same time, a performance appraisal system was being piloted (and is now implemented statewide) to reflect and support the growth of school staff members in those elements demonstrated by research to be characteristic of effective teachers.

In the Summer of 1987, the Delaware General Assembly and the Department of Public Instruction established a task force to review the nature and use of higher order thinking skills in Delaware schools. A recommendation of this task force called for the development and implementation of a state-wide staff development program for enhancing higher order thinking for all students at all grade levels in all content areas. This training module is a part of that program and of a general effort to expand the elements of effective instruction introduced statewide in 1986-87.

HIGHER ORDER THINKING

"Problem Solving/Decision Making"

A Module for Staff Development

1. OBJECTIVES

- Participants will know the steps in Creative Problem Solving.
- Participants will participate in brainstorming and S.C.A.M.P.E.R., two "idea finding" techniques used in problem solving and decision making.
- Participants will identify teacher behaviors that promote problem solving/decision making and those that hinder it.

2. WARM-UP

- After two (2) minutes "think time," participants should share their responses to the following image: "Schools are like amusement parks because. . ."
- Process what kind of thinking occurred to complete the metaphor.

3. DOT PROBLEM: FINDING WAYS "OUT OF THE BOX"

- Transparency/Handout - "Dot Problem"
  Challenge participants to solve the puzzle.
- After 3-4 minutes, ask for solutions.
- Ask, "Why was this difficult?" (perception of "box" prevented solution for some)
- Show other solutions to dot problem from Conceptual Blockbusting.
  Transparencies - "Other Ways Out of the Box." (The last solution requires a very thick line - or piece of folded paper - to be drawn through all the dots at once.)
- Discuss how dot problem is related to real-life problem solving.

4. CREATIVE PROBLEM SOLVING (CPS): INTRODUCTION

- Think-Pair-Share about the changes in the world since participants were children.
- Present Handout/Transparency - "Problem Solver's Credo" and definition of CPS.
- Even simplest problems have unique solutions:
  Transparency - "3 Ways To Top Of A Tree."

- Present Handout/Transparency - "Creative Problem Solving at a Glance"
- Refer to Handout - "Creative Problem Solving" for more detailed information.

5. FUNNEL THINKING: DIVERGENT & CONVERGENT PRODUCTION

- Use Transparencies - "Funnel Thinking (IWWMI)" and "Funnel Thinking (GAWIB)" to discuss divergent and convergent thinking. (Reference, pp. 24-27 from Help! in Solving Problems Creatively at Home and School)
- Using Funnel Thinking transparencies/handouts, have participants identify which thinking skills and what levels they represent in 3-Story Intellect (Handout).
- Transparency - "Lead-ins for Problem Solving"

6. CPS STEP 1: SENSING PROBLEMS AND CHALLENGES OR "MESS FINDING"

- Do exercise, Handout - "Mess Finding" individually. Then, share three (3) most meaningful problems as they relate to "THINKING" with people at tables.
- Discuss the fact that there will always be problems to solve (Transparency - "Cartoon about Story Problems") that go beyond story problems."
- Groups at tables should determine one (1) area that their group can decide interests them (an area for a problem solving exercise to follow).

7. CPS STEP 2: FACT FINDING

- elicit some definitions and reasons for fact-finding (way to get a "handle" on the "mess" and a step closer to problem identification.
- "What kind of thinking happens here?"
- Groups do some fact finding about their chosen problem area.

8. CPS STEP 3: PROBLEM FINDING

- Transparency - "John Dewey Quote"
- Discuss importance of problem finding/definition - the need to first consider the many problem possibilities in the "mess" before finally arriving at one.
- Groups should go through problem finding process for their area and state problem in IWWMI (In what ways might I/we. . .) form.
- "What kind of thinking happens at this step?"

9. CPS STEP 4: IDEA FINDING

- Here, divergent thinking is required, there is a need to strive for lots of ideas.
  Transparency - "Masefield Quote"
- Do practice Brainstorming (Transparency): from Handout - "How to Exercise your Idea-Finding Power," #_____ and share ideas.
- Transparency - "Divergent Production" used to examine group ideas for fluency, flexibility, elaboration and originality.
- Groups brainstorm ideas to solve their problem.
- Second idea finding technique is S.C.A.M.P.E.R. (Handout).
- Transparency - "Sandwiches" to show flexible thinking, critical for creativity.
- Review S.C.A.M.P.E.R. (Handout), asking for examples from advertising, for example, where ideas have originated.
- Groups do S.C.A.M.P.E.R. with their problem.
- Transparency - "Idea Killers" - discuss these and other ways to kill ideas.
  Transparency - "Funny Business"
- Transparency - "Paradoxes - example of the attitude necessary for idea finding. Discuss other necessary teacher behaviors.
- "What kind of thinking happens at this step?"

10. CPS STEP 5: SOLUTION FINDING

- List kinds of evaluative criteria, e.g. the "yardsticks" to measure the worth of an idea. (cost, time, effect, availability of resources, effects on me/others, ease of implementation, suitability, ease of understanding, high motivation, law hostility, socially sound, safety, no special provisions necessary, durability, etc.)
- Discuss evaluation methods. Transparency - "Barber Cartoon"
- Review PMI (Plus, Minus, Interesting) from Module 1.
- Participants select and apply evaluative criteria to each of their ideas. Hand-out: 'Solution Finding'
- "What kinds of thinking happened here?"
- Transparency - "Torrance Quote"

11. CPS STEP 6: ACCEPTANCE FINDING

- Having an idea accepted by others requires thoughtful planning. Discuss and list the kinds of things that must be considered to get an idea accepted.
- Groups plan way to get their idea accepted.
- "What kinds of thinking occurred?"

12. REVIEW: STUDY BUDDY FOR STEPS TO CPS

13. DECISION MAKING

- Transparency - "Hagar Cartoon"

- Transparency - "Decision Making Model"
- Compare/contrast decision making to problem solving in small groups; share as a whole group.
- Discuss attitudes necessary for thoughtful decision making.
  Transparency - "TRW Quote"
- Decision making practice individually - "What should we do with the walls in the faculty room?"
- "What kind of thinking occurred?"

14. • Transparency - "LIFE"
  - in the middle is "if"

15. • Wrap-Up: Analogy
  - "Problem solving is like childbirth because. . ."

HANDOUTS

Make four (4) lines connecting all the dots
without taking your pencil off the paper.

THE PROBLEM-SOLVER'S CREDO

NOTHING IS DONE

Nothing is done. Everything in the world remains to be done, or done over. The greatest picture has not been painted. The ideal labor contract is yet unwritten. An easy way to keep slim, a better way to fight crime, a complete cure for cancer, all of these problems remain unsolved.

No one product has ever been manufactured, advertised, distributed, and sold as efficiently as it should be and some day must be. There isn't in all the land a perfectly managed government, business, home, school, or classroom.

Nothing is known positively and completely. Nothing is done finally and right. Everything changes. So the world waits and then moves forward in surges, as here a man and there a woman make fresh and daring discoveries or propose some bold new ideas. And most, if not all, of these contributions to social and scientific progress come from creative individuals who have the courage and strength to challenge and break the bonds of conventional, routine, average thinking.

— Anonymous

FROM: HELP! In Solving Problems Creatively at Home and School
Bob Eberle. Good Apple, 1984

CREATIVE PROBLEM-SOLVING? LET'S DEFINE IT.

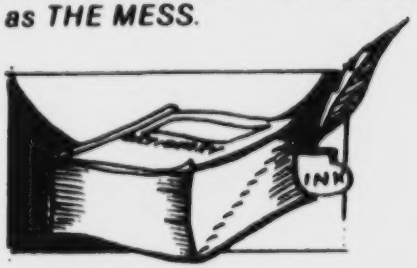
CREATIVE - having a quality of originality; inventive, new, different . . . at least to you the creator.

PROBLEM - any vexing situation; a concern, opportunity, or challenge . . . there are no pat answers at hand.

SOLVING - coming up with ways to untangle a knotty problem; answers, solutions, responses are found.

CREATIVE PROBLEM-SOLVING is a system, a method, a plan for dealing with perplexing situations.* Involved is the production of unique, imaginative ideas which lead to effective action.

**In the pages that follow, perplexing situations will often be referred to as THE MESS.*



"From a little spark may burst a mighty flame."
— Dante

CREATIVE PROBLEM-SOLVING AT A GLANCE

STEP I. SENSING PROBLEMS AND CHALLENGES*

↓

You feel that something could be improved.
You are alert to perplexities that exist.
You are determined to work things out.
You are willing to apply your creative power.

STEP II. FACT-FINDING

↓

You are willing to dig in and get the facts.
You get information as an aid to understanding.
You get at the cause of the situation.
You ask questions to find out for sure.

STEP III. PROBLEM-FINDING

↓

You look at the puzzle and see the parts.
You see sub-problems that make up the "mess."
You select a bite-sized problem for attack.
Your problem statement begins with "In what ways might I" (IWWMI?).

* Refer to pages 7 - 9.

FROM: HELP! in Solving Problems Creatively at Home and School
Bob Eberle. Good Apple, 1984

STEP IV. IDEA-FINDING

↓

You use your creativity to think up ideas.
You think of different, far-out ideas.
You come up with a large number of ideas.
You stretch your imagination to the fullest.

STEP V. SOLUTION-FINDING

↓

You look over your list of ideas.
You determine what ideas might work out.
Using measures, you judge your ideas.
You select the ideas that are judged best.

STEP VI. ACCEPTANCE-FINDING

↓

You figure out ways to implement your idea.
You determine what needs to be done.
You assess the difficulties that may arise.
You prepare a plan and start the action.

Pages 16-17 are adapted from Noller, Parnes, and Biondi (1976).

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Problem Solving Techniques

Group Planning and Decision-Making:

Problem-solving has value as a group approach to perplexing situations that may arise in the classroom. Be it a social situation or a learning activity, pupils may suggest ideas and work cooperatively and creatively to solve a problem. Once ideas have been evaluated and a solution has been found, plans may be made to implement the solution selected. (To demonstrate what we have learned, what are some of the things we might want to do at the end of our unit on conservation? So that everyone is pleased, how might we plan for the class party?)

Outcomes of Interactive Problem-Solving:

As a personally involving activity, problem-solving stimulates pupil growth in the following ways:

1) Thinking powers are developed.
2) Feelings and attitudes are respected.
3) Free and open discussion becomes natural.
4) Creative thinking is stimulated.
5) Personal strengths and talents are discovered.
6) Students learn to take the initiative and to become leaders.
7) Learned skills have transfer value.
8) Self-sufficiency is enhanced.

Applying the Problem-Solving Method:

While playing the role of an inquirer, the teacher encourages pupils to generate information as opposed to receiving and storing knowledge. Through answering questions, pupils build-up a store of information and ideas which is used to creatively solve problems. The format which appears on the following pages, provides information and questions which will be helpful to the teacher. In applying the step-by-step method, however, it will be necessary for the teacher to be selective in the use of the questions to suit a particular situation.

The step-by-step method contains built-in flexibility. The time and effort needed to solve problems will not be the same in all cases. The seriousness of the situation and the depth of concern that is expressed will help to determine the time and efforts that should be expanded. Roughly, interaction may take place at three levels of involvement:

1. *Streamlined Approach* - *For the most part, fact finding and idea production is a verbal exchange between the teacher and pupil. In a one-to-one guidance type discussion, the teacher seeks to assist a pupil in solving a personal problem. (Mary, you seem to be unhappy in this class, am I right in this belief? What might be done to make this class more enjoyable for you?)*

2. *Middle-of-the-Stream Approach* - *Fact-finding and idea production may be verbal, but a record of ideas and suggestions will be kept. Task groups may be formed or the entire class may be involved. The problem will be of moderate complexity but will pose rather serious consequences for more than one person if it is not solved. (How might we help those individuals that do not understand fractions?)*

3. *Main-Stream Approach* - *The entire class is engaged in fact-finding and idea production. The step-by-step procedure is implemented in a formal manner and documentation and note-taking occur at each step. Due to the scope and nature of the problem, a considerable amount of time may be spent in seeking a solution. (To make the lunchroom a quiet and enjoyable place to eat, what might be done to eliminate the noise and confusion?)*

Step 1 -- *Teacher Sensitivity to Problems and Conflicts*:

Like a radar beam scanning the countryside for an impending storm, the teacher must be keenly alert and highly sensitive to the feelings and concerns of pupils. To allow oneself to become overly-involved in content teaching may result in a "blindness" to the personal needs of pupils. Teachers giving it "their all" to bring about academic excellence often develop a numbness to the emotional needs of pupils. Before a problem can be solved, it is necessary for the teacher to know that one exists. Using the entire classroom as a field of vision, the teacher should frequently observe pupils like a television camera traversing the scene of activity. When eye contact is made, it becomes possible to sense the moods and anxieties of pupils. When it appears that trouble may exist, terse questioning helps to discover problems and difficulties:

1) Are you alright?
2) Is something bothering you?
3) Are you confused?
4) Is there anything that you wish to tell me?
5) Is everything O.K.?
6) Is something messed-up?

Through give-and-take conversation the teacher is able to determine problem situations. Once perplexities are made known, it then becomes possible to determine the appropriate next steps.

Step 2 -- *Fact-Finding:*

Having discovered that concerns and perplexities exist, the interactive process leading to an acceptable solution may begin. Rather than "jumping in" with suggestions on what to do about it, Step 2 centers on the gathering of factual information about the situation:

1) What is bothering you? Is that all there is to it?
2) What is causing you to be confused? Is there anything else?
3) What is making you feel badly? Who else is involved?
4) What keeps getting messed-up? Why does this happen?
5) Tell me what you know about it for sure?
6) Do we need to know more about it? Who can tell us?
7) Let's review all of the facts.

As a "gates open" approach to gathering information, all contributions are welcome if their factual basis can be established. Once pertinent facts are available, the gravity of the situation can be determined and a problem statement can be formulated.

Step 3 -- *Problem Identification:*

Using the factual information that has been collected, it is now possible to focus attention on the "real problem situation." It is well to remember that a problem must be "trimmed down to size" and specifically identified before it can be solved creatively. Questioning designed to pin-point the problem may result in the following:

a) By identifying the problem, an acceptable solution may come to mind making it unnecessary to continue with the remaining steps.
b) It will be discovered that more than one problem exists. It then becomes necessary to select the problem that appears to be the most bothersome or otherwise first priority.
c) A single, encompassing problem is identified for creative attack.

A problem well-identified is a problem half-solved. To aid in the identification of problems, ask:

1) What is the basic issue?
2) What do you want to happen?
3) What one thing do you want to improve upon?
4) What exactly do you really want to get done?

In answering the previous questions, pupils should respond with a statement: *"I want . . ." or "We want . . ." (I want Tom to stop throwing rocks at me.) (We want more time to eat our food in the cafeteria.)* The statement should then be written in the form of a question: *"How might I . . ." or "In what ways might we . . . " (In what ways might I convince Tom to stop throwing rocks at me? In what ways might we gain more time to eat our lunch?)* It should be noted that questions phrased in this manner call for multiple and varied responses. After comparing the written questions, the one with the greatest potential for solving the problem is selected.

Step 4 -- *Idea Production*:

Sometimes called "Brainstorming," Step 4 engages pupils in the fluent production of unique and original ideas. If a "pat answer" to the problem existed, or no alternatives were present, it would not have been necessary to initiate the problem-solving process. To introduce the "brainstorming session," say to pupils:

1) We need your ideas, all ideas are welcome.
2) Try to think of ideas that no one else will think of.
3) We want some "far out" ideas.
4) Wild ideas may lead us to something good.
5) Combine the ideas that others give to create another idea.
6) Don't worry if your idea is good enough, give it to us and we will judge it later.

Call for ideas in answer to the "How Might We?" question and record them on a flip chart or chalkboard for later reference. Close the session when it appears that pupils have run out of ideas.

Step 5 -- *Finding a Creative Solution*:

Refering to the ideas produced in Step 4, it now becomes possible to arrive at a solution. First, place a single check-mark in front of each idea that offers promise. By combining and restating ideas, the list should be then narrowed down to five ideas. These five ideas should then be evaluated using criteria similar to those given here:

1) How well does it get at the heart of the problem?
2) Is it fair to all concerned?
3) Will it be acceptable to the greater number of people?
4) Is it easily implemented?
5) Do you have the resources to carry it through?
6) Are the time requirements acceptable?
7) Will it last over an extended period of time?

Using the above criteria, a point system for a creative solution to the problem may be selected.

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Step 6 -- *Implementing the Solution*:

Having arrived at a creative solution to a problem does not mean that the problem is automatically solved. Step 6 provides for the planning and organizing needed to put the solution into effect. Answers to the following questions will be helpful in preparing an implementation plan:

1) In what order do things need to be done?
2) Who will have the responsibility for doing what?
3) What time-table will be used?
4) Who will need to know about the plan?
5) How will we check to see if things are being done?
6) How will we know when the problem has been solved?

Other questions may be developed to suit a particular situation.

Summary:

Interactive Problem-Solving is a way to involve people in making decisions that effect them personally. When people are involved personally they develop a "stake" in things and are willing to work to reach a desired end. Personal involvement and interaction are the keys that open the door to improved understanding and appreciation of others.

For information concerning the Creative Problem-Solving Institute, write to:

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THE THREE-STORY INTELLECT

OUTPUT

EVALUATE
GENERALIZE
IMAGINE
JUDGE
PREDICT
SPECULATE
IF / THEN
APPLY A PRINCIPLE
HYPOTHESIZE
FORECAST
IDEALIZE

PROCESS

COMPARE
CONTRAST
CLASSIFY
SORT
DISTINGUISH
EXPLAIN (WHY)
INFER
SEQUENCE
ANALYZE
SYNTHESIZE
MAKE ANALOGIES
REASON

INPUT

COMPLETE
COUNT
DEFINE
DESCRIBE
IDENTIFY
LIST
MATCH
NAME
OBSERVE
RECITE
SELECT
SCAN

IDI

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MESS FINDING

When questions in the left column are coupled with questions in the right column, perplexing situations may be brought to mind. For example, when Item 2 and Item D are coupled, it might suggest, "My pupils don't care if they learn or not."

Try a number of combinations in search of problems that have particular meaning for you.

1. Classroom?	A. Improvements?
2. Pupils?	B. Complications?
3. Curriculum?	C. Behavior?
4. Colleagues?	D. Attitudes?
5. Social life?	E. Anxieties?
6. Parents?	F. Inefficiency?
7. Administration?	G. Routine?
8. Instructional?	H. Demands?
9. Job?	I. Performance?
10. School Board?	J. Limitations?

*Adapted from Noller, Parnes, and Biondi (1976).

HOW TO EXERCISE YOUR IDEA-FINDING POWERS*

1. Name at least six improvements which could be made on a common paint brush.

2. Name five inventions which the world could use to advantage, but which have not yet been invented.

3. What improvement in a bus would you suggest for the comfort and convenience of passengers?

4. If you had the job of drastically redesigning the $.50 piece, what would you suggest for the head and for the tail? Give your reasons.

5. What new ideas could be added to the game of baseball to make it more interesting and fun to play?

6. Write a twenty-word telegram to a friend telling about one day in school.

7. Write a classified ad offering for sale a pocket-sized exercise kit, a bed-making machine, or a device to make toothpicks.

8. Name several things you could make by combining the items in each group:

   a. a volley ball and a steel spring
   b. 13 empty pop bottles and 72 ounces of water
   c. a board (1/2 inch thick and 3 feet square), a stick, and a hinge.

9. Describe an idea for a TV show which you think a lot of people would watch, but which has never been done before.

10. What would be the results if all people woke up one morning and found themselves twice as large?

11. If you neighbor's dog used your garden as a short-cut, how would you go about stopping this?

12. In what ways would you improve children's phonograph records?

13. Think of ten uses for Scotch tape that you have never heard of.

14. What parts of a home might be improved if they were curved instead of straight?

15. What ideas could you suggest to help a mother persuade her child to clean up his room?

16. Think of at least three ways to wake people up in the morning, gently but firmly.

17. Everyone has something that "bugs" him. Write down three of yours - then make some creative suggestions as to what to do about them.

18. In what ways would our lives be affected if the wheel had never been invented?

*Selected from Applied Imagination by Sidney J. Parnes and Alex Osborn.

19. Think of some better ways of collecting garbage in order to avoid the noise of the present system and unsightly cans or bags at the curb.

20. Make up a story which will include all of the items in "a" or "b":

    a. a gray cat, a box of marshmallows, yesterday's newspaper, a pair of pajamas; a policeman.
    b. a campfire, two gravediggers, a bowl of rice, a blueberry bush, and a clown.

21. Name a subject you have studied which seems useless to you. Now, make a list of possible uses for this subject. Try for ten ideas. Now try for fifteen or twenty. Now, what do you think of the subject?

22. Select a new title for each of ten chapters in any of your textbooks. Make the title exciting enough to be a movie, but yet appropriate to the contents of the chapter.

23. Originate ten new weird food concoctions.

24. Suppose you were developing an illustrated alphabet book for children who are very fond of automobiles and anything closely associated with them. Pick an "automobile" word for each letter of the alphabet. (You may use any subject of your choice.)

25.

26.

27.

28.

29.

30.

SCAMPER*

— an idea-spurring checklist —

The word *scamper* suggests "running playfully about as a child." It may also suggest "to run playfully about in one's mind in search of ideas." Used as an acronym, each letter has application to a questioning process designed to stimulate idea production.

S—SUBSTITUTE	To have a person or thing act or serve in place of another. Who else? What else? What other place? Other time, routine, process?
C—COMBINE	To bring together, to unite. Combine what? Combine ideas? Combine purposes? Combine approaches? Combine materials? How about a blend, assortment, or ensemble?
A—ADAPT	To adjust with the intention of suiting a condition or purpose. How to make it suitable? Applicable? More agreeable? More accommodating, compatible, consistent?
M—MODIFY	To alter. To change form or quality. Change color? Change shape? Change motion, sound, form, size, taste?
MAGNIFY	To enlarge. To make greater in form or quality. How to make stronger, thicker, higher, bigger, deeper? More intense?
MINIFY	To lessen. To minimize. What to make smaller? Lighter? Slower? Less frequent? What to shrink, reduce, diminish?
P—PUT TO OTHER USES	Use for a purpose other than originally intended. New ways to use as is? Other uses if modified? Other places, people?
E—ELIMINATE	To remove, omit, or get rid of a quality, part, or whole. What to cut out? Remove? Simplify? Make sparse, rare, scarce?
ELABORATE	To add details. What to enhance? Make brighter? Ornamented? Enriched? Ornate? Fancy?
R—REVERSE	To place opposite or contrary. What to turn around? Turn backwards? Upside down? Inside out? Give a 180° flip?
REARRANGE	To change order or sequence. Other pattern? Other layout? Other allotment? Other method?

*Eberle 1971, as adapted from Osborn, 1963.

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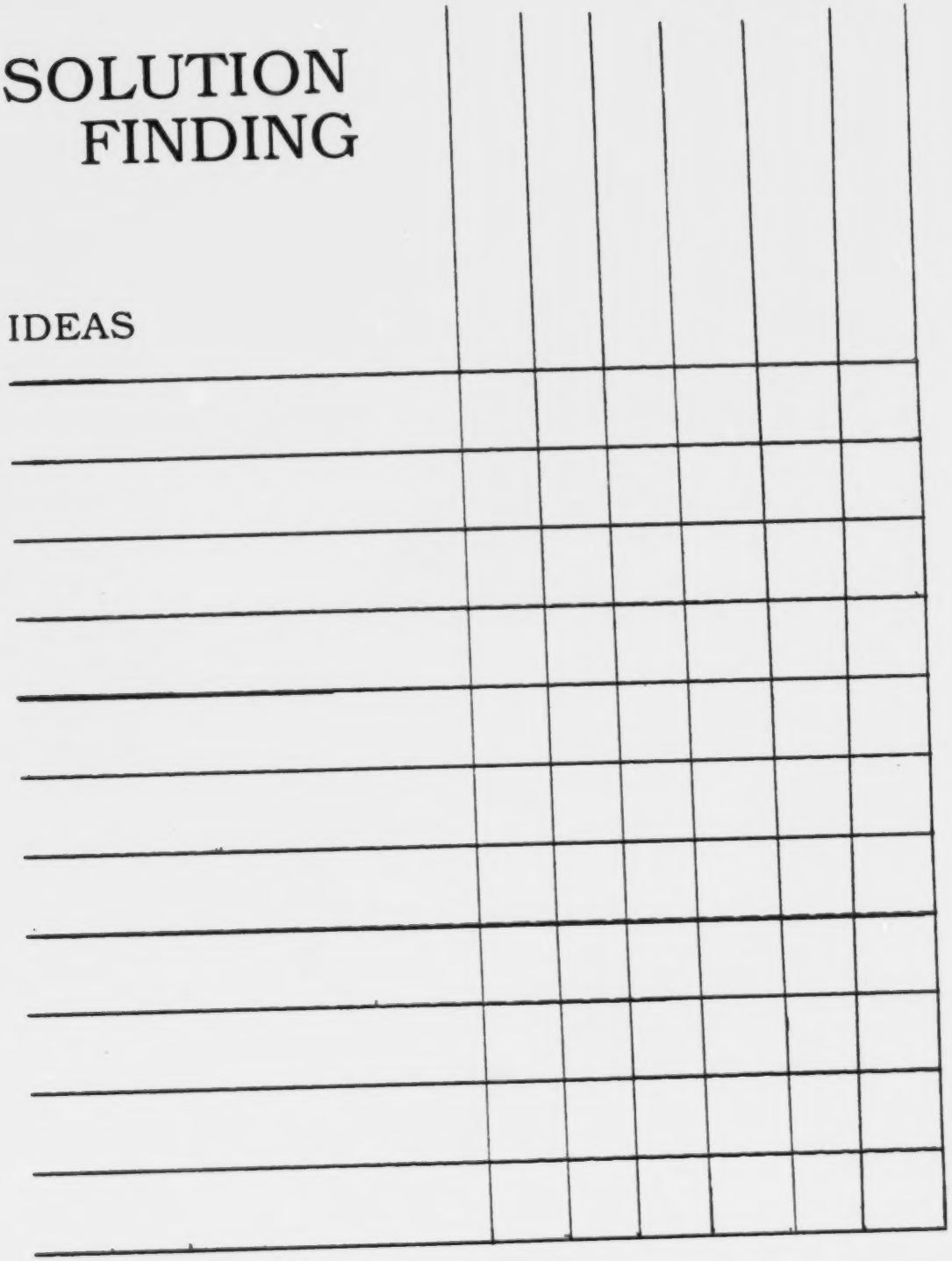
HELP! in Solving Problems Creatively at Home and School
by Bob Eberle

CRITERIA

SOLUTION FINDING

IDEAS



CHARLES E. WALES, ANNE H. NARDI, AND ROBERT A. STAGER

Decision Making: New Paradigm for Education

Schooling should focus not only on knowledge but on the decision-making skills students need to use knowledge intelligently.

Five hundred years ago people like us believed not only that the Earth was flat but that it was the center of the universe. Fifty years ago respected scientists ridiculed those of their number who suggested that continents might move on great plates. Both examples show one side of the nature of human progress, resistance to change. Fortunately, there is another side that responds when observations and beliefs no longer agree. That side is willing to consider a new paradigm.

Education stands at such a crossroads today. Some people believe or want to believe that education achieves what it promises. "This promise means that all children ... can hope to attain the mature and informed judgment needed to secure gainful employment, and to manage their own lives."[1] On the other side are those who claim that these beliefs are misplaced, that education does not achieve its promise because schools emphasize factual knowledge and facts alone do not build judgment, secure employment, or manage lives. "The task," they say, "is to produce a changed environment for learning—an environment in which there is a new relationship between students and their subject matter, in which knowledge and skill become objects of interrogation, inquiry, and extrapolation. As individuals acquire knowledge, they also should be empowered to think and reason."[2]

These critics call for a new paradigm based on the thinking skills that make knowledge useful. "Schools must also expand the definition of what is basic to a quality education. We believe that definition should include the ability to think critically, to analyze issues, to formulate solutions to problems, and to ask and seek answers to questions."[3] If critics have their way, the new basics of schooling will focus

How Journalists and Actors Define Problems

A helpful approach to defining the problem situation is to visualize it the way persons who think in images do. Theatre people, for example, think in terms of the actors, props, and action in each scene in a dramatic sequence of scenes. This theatrical approach is analogous to the journalist's more analytical and verbal way of looking at a situation. Journalists ask who-what-when-where-why-how. When these *words* are combined with the *components* of the theatrical approach, the result is the following set of *basic analytic questions*

Theatre	Journalism
Actors:	Who is involved?
Props:	What is involved?
Action:	What happened?
Scene:	When did it happen?
	Where did it happen?
Cause:	Why did it happen?
Consequences:	How frequent, serious, and extensive is it?

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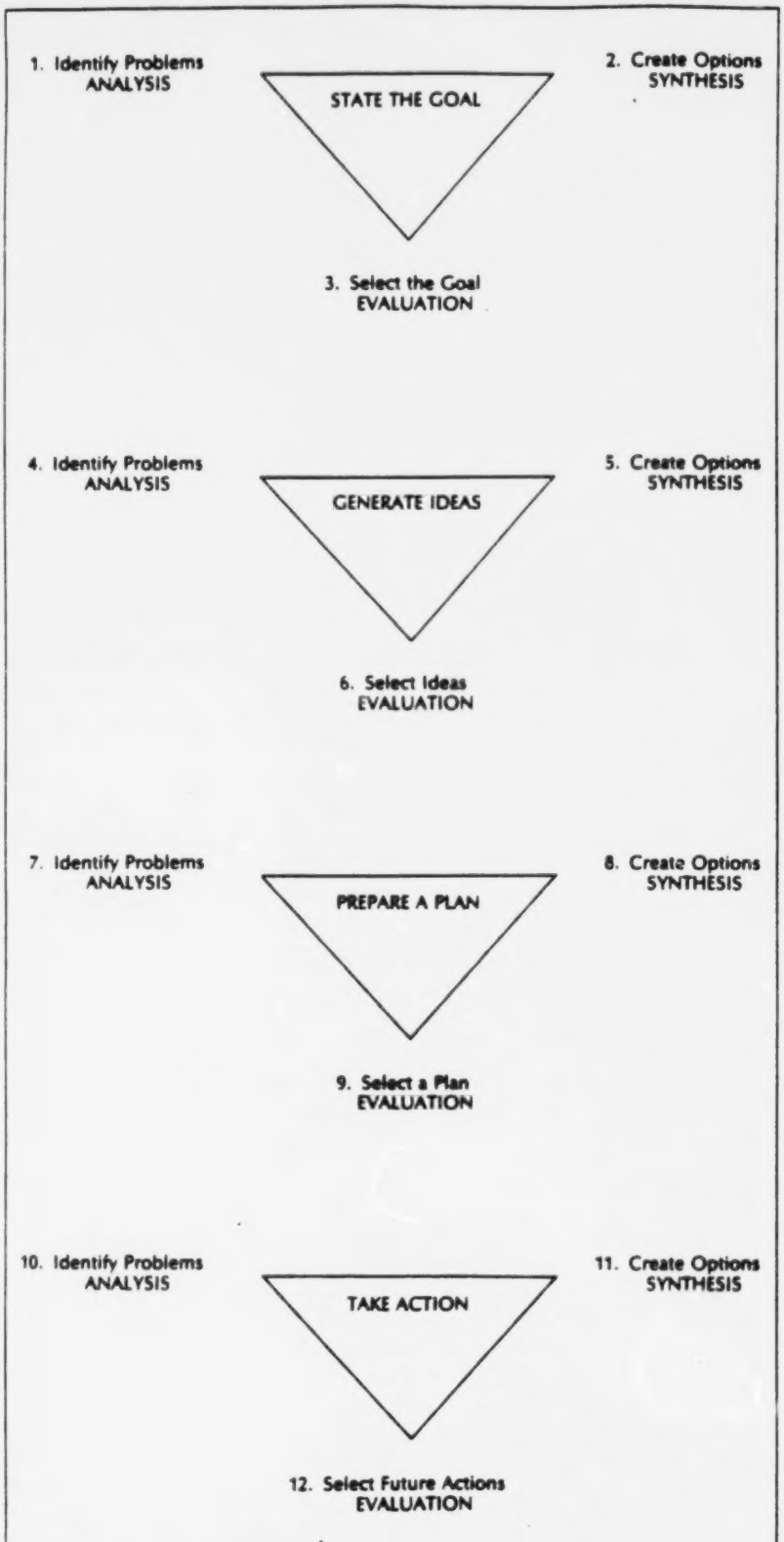

Fig. 1. The Decision-Making Process

29

on both knowledge and thinking skills. But the pendulum can't swing toward a new paradigm based on thinking until appropriate skills have been defined.

Most employers want graduates who know how to anticipate consequences and make decisions. Decision making gives thinking a purpose. Through our decisions, which are based on what we have learned both in and out of school, we determine the course of our lives. We make decisions that affect both our success as workers and our success as people. Since this is the promise of education, it seems clear that the new paradigm should be:

> Schooling focused on decision making, the thinking skills that serve it, and the knowledge base that supports it.

If education is to emphasize decision making, educators must understand the decision-making process. Our understanding would be enhanced if people thought out loud as they made decisions, but for most people thinking is both spontaneous and subconscious. At the Center for Guided Design, West Virginia University, we set out to learn what actually happens during those moments when the human brain outperforms even the best computer. We discovered that the basic decision-making process involves four operations: state the goal, generate ideas, prepare a plan, and take action[4] (fig. 1). At first glance, our model of the decision-making process may appear to be fairly complex. However, once you learn the basic pattern for each of the thinking modes, the process is relatively easy to use. The characteristic activities in each decision-making-*analysis* (steps 1, 4, 7, and 10, fig. 1) are to visualize appropriate components and analyze to identify anything that *might be*, contribute to, or cause a problem.

In a similar way, each decision-making-*synthesis* (steps 2, 5, 8, and 11) has these characteristic activities: to imagine what *could be* and generate options; to integrate ideas and synthesize combinations.

And each decision-making-*evaluation* (steps 3, 6, 9, and 12) has these characteristic activities: to consider previous selections, specify constraints and assumptions, and anticipate con-

* The house sure is quiet when the rest of the family is away. That's probably why I overslept. It's 7 o'clock already. I have to shower, dress, eat, and be at work by eight. I can't be late today; my meeting is much too important. The drive shouldn't take more than 15 minutes, if traffic cooperates.

1. I wouldn't be in trouble if I'd been up on time. Breakfast is the problem. I don't have enough time for breakfast, but I'll run out of energy by 10 o'clock if I skip it.
2. I'd better eat, but it has to be fast. "Have a nutritious breakfast," Mom would say. But what's wrong with quick energy? I could have a couple of doughnuts.
3. Mom is probably right. Given my schedule today I'll have something nutritious. But it has to be fast so I can get to work on time.

4. Finding something that is both nutritious and easy to fix and eat could be a problem.
5. How about a peanut butter-and-jelly sandwich and milk; that's got all four groups. Or that leftover pizza. Why not a cheese omelet, toast, and juice? I could eat that here or at three or four fast food places on the way to work.
6. A cheese omelet, toast, and juice sounds good, but I don't have time to cook it here. I'll go out.

** I think I'll start for work and keep my eye peeled for a fast food place that is not too busy.

7. Traffic might be a problem. Finding a place that is not too busy this time of the morning would be a problem too.
8. Let's see, Wendy's is not too far away. McDonald's, Hardee's, and Burger King are closer to work.
9. To be sure I get there on time I'd better eat close to work. I can judge the crowd by the number of parked cars.

10. Do I have my keys, wallet, and money? Oh, oh! I didn't know it had started to rain. That will slow traffic.
11. Traffic is a mess; I'd better reconsider my options. I'll use a drive-in window if necessary.
12. Even though I had to eat at work, that was a good breakfast. And I made my meeting on time. Next time I'll get up earlier.

Fig. 2. The Breakfast Problem

sequences, to evaluate and select what *should be*.

Everyone has internalized an informal decision-making strategy, usually an eclectic approach derived from experience and observing other people. Our research findings can best be explained by examining a slow-motion picture of someone making a decision. We will examine a familiar scenario. Almost every morning each of us must face the four "gets": get up, get dressed, get breakfast, get to work. Imagine a complication: our decision maker overslept and must be at work on time for a very important meeting. Figure 2 is a chronological narrative of the thoughts of a person getting up, realizing he is late, and attempting to come to grips with a way to make up time *and* eat a nutritious breakfast. To deal with this problem systematically, he can apply the decision-making process built on the thinking modes of analysis, synthesis, and evaluation. The three-part pattern is used in sequence at each decision-making operation: in step 1 the focus is on analysis, step 2—synthesis, step 3—evaluation, and so on, as shown in figure 3.

Before our decision maker can begin to apply these three thinking modes, though, he must define the problem-situation. The decision maker must "see" what's involved before he begins the first step in the goal operation. If he has not personally experienced the actual situation, he may have to construct an image in his mind's eye. The first paragraph in the Breakfast Problem (fig. 2) serves that function.

Decision makers must answer questions necessary to analyzing and solving problems through their own resources, by gathering information

Problems are identified in steps 1-4-7-10:

1. I don't have enough time for breakfast.
4. Find something nutritious and easy to fix and eat.
7. Traffic might be a problem. A place that is too busy.
10. Do I have my keys, wallet, and money? Rain will slow traffic.

The primary activity here is *ANALYSIS*.

Options are generated in steps 2-5-8-11:

2. Nutritious, quick energy, doughnuts.
5. Peanut butter, pizza, cheese omelet. Eat here or fast food out.
8. Wendy's, McDonald's, Hardee's, Burger King.
11. Use a drive-in window if necessary.

The primary activity here is *SYNTHESIS*.

Selections are made in steps 3-6-9-12:

3. Something nutritious, but fast.
6. An omelet. Eat out.
9. Eat close to work where there are few cars.
12. Get up earlier next time.

The primary activity here is *EVALUATION*.

Analysis, Synthesis, and Evaluation are the primary *Modes of Thinking* used in the decision-making process. They are used in sequence: in step 1 the focus is analysis, step 2—synthesis, step 3—evaluation, step 4—analysis, etc., as shown here.

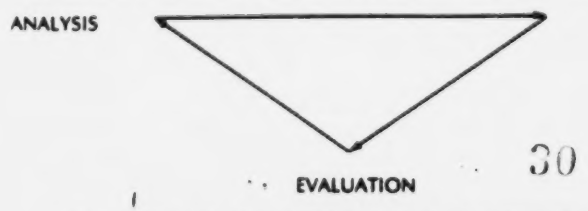

Fig. 3. Three Modes of Thinking in the Breakfast Problem

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Steps 1-2-3 result in a Goal.

1. I don't have enough time for breakfast.
2. Nutritious, quick energy, doughnuts.
3. Something nutritious, but fast.

Steps 4-5-6 focus on Generating Ideas that might achieve the goal.

4. Find something nutritious and easy to fix and eat.
5. Peanut butter, pizza, cheese omelet. Eat here or fast food out.
6. An omelet. Eat out.

Steps 7-8-9 result in a Plan.

7. Traffic might be a problem. So is a place that is too busy.
8. Wendy's, McDonald's, Hardee's, Burger King.
9. Eat close to work where there are few cars.

Steps 10-11-12 focus on present and future Action.

10. Do I have my keys, wallet, and money? Rain will slow traffic.
11. Use a drive-in window if necessary.
12. Get up earlier next time.

Fig. 4. Four Operations

from the library or other media, from experts, or through experimental work. All of this work toward defining the problem-situation has one purpose: it allows decision makers to identify difficulties in the analysis step that follows.

To return to the Breakfast Problem, let's look at another pattern that is revealed when we examine each set of three steps (fig. 4). Each set of steps has a *focus* and a *result*. When the four operations shown in figure 4 are combined with the three thinking modes in figure 3, the result is the complete decision-making process, the 12-step model of figure 5.

Analysis

The key to beginning each of the four operations is a visualization of what was selected in previous steps so that anything that might be, contribute to, or cause a problem can be identified. In step 1 (fig. 5) problems are identified by probing the consequences defined in the situation. The other three analysis steps differ because they are

DEFINE THE SITUATION

* Observe or visualize the situation that exists and analyze to define the actors, props, action, scene, cause, and consequences.

STATE THE GOAL

1. *Identify Situation Problems.* Analyze to define what it is about the consequences of the situation that might be, contribute to, or cause a problem.
2. *Create Goal Options.* Imagine what could be and generate goal options that solve each problem. Integrate ideas and synthesize goal statements.
3. *Select the Goal.* Specify musts and wants, constraints and assumptions, anticipate future consequences, evaluate, and select the best goal.

GENERATE IDEAS

4. *Identify Goal Problems.* Analyze to define what it is that might be, contribute to, or cause a problem if the goal is to be achieved.
5. *Create Idea Options.* Imagine what could be and generate idea options that solve each problem. Integrate ideas and synthesize combinations.
6. *Select Ideas.* Consider the goal, specify additional constraints and assumptions, anticipate future consequences, evaluate, and select the best combination of ideas.

DEFINE THE NEW SITUATION

** Visualize the situation that results if the selected ideas are implemented and analyze to define the actors, props, action, scene, cause, consequences plus any construction, operation, and the cost/benefits.

PREPARE A PLAN

7. *Identify New Situation Problems.* Analyze to define what is it about the new situation that might be, contribute to or cause a problem.
8. *Create Plan Options.* Imagine what could be and generate plan options that solve each problem. Integrate ideas and synthesize detailed plans.

TAKE ACTION

10. *Identify Plan Problems.* Visualize or rehearse the plan. Analyze to define what it is that might be, contribute to or cause a problem when the plan is implemented.
11. *Create Action Options.* Physically implement the plan. Imagine what could be and generate action options that solve each problem if necessary.
12. *Select the Next Action.* Compare the results of the action with the goal, the selected ideas, and the plan. Specify constraints and assumptions, anticipate future consequences, evaluate, and select the best future action.

Fig. 5. The Decision-Making Process

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based on selections made by the decision maker. In step 4 the goal that was selected must be pictured and analyzed to identify what might be, contribute to, or cause a problem when it is implemented. Step 7 is still more complex because the decision maker must visualize and analyze the implementation of the ideas he believes will best solve the problem. In step 10 the visualization may be a mental or physical dry run or rehearsal of the plan that has been selected.

If the selected plan is to accomplish something, the decision maker can identify problems by asking, "What problems might prevent this from being achieved?" If, on the other hand, the plan is to prevent or reduce something, he might ask, "What might contribute to or cause a problem?" This focus on "problems" is extremely important because each problem serves as the basis for the synthesis step that follows.

Synthesis

To begin each synthesis step, the decision maker identifies the mirror image of each problem. If the problem is not having enough time for breakfast, then the mirror image is to have a "fast" breakfast. If the problem is running out of energy by 10 o'clock, the mirror image is to have a "nutritious" breakfast. In each case the mirror image serves as the basis for generating options. The decision maker imagines what could be and generates options that might solve the problem; he visualizes the future. Some people use a divergent thinking technique such as brainstorming, synectics, or lateral thinking to enhance the imagination required to generate alternatives.

The options must now be integrated and synthesized to produce tentative *goals* (step 2), *ideas* (step 5), *plans* (step 8), and *actions* (step 11). The goals, ideas, and plans are tentative because they must still be judged in the evaluation step that follows. The actions in step 11 are different in that tentative actions must be incorporated into the physical synthesis of the system—the plan is implemented—and while options exist, the result is a product—building, process, operation, invention, machine, concept, book, poem, song, or painting.

Evaluation

Before tentative goals, ideas, or plans can be evaluated, any constraints and assumptions that apply to the situation must be specified. The constraints may be limitations of people, money, equipment, time, or technology. Assumptions may be made to offset these problems. Then the implemented idea must be visualized so the consequences of each alternative can be anticipated. It is the combination of all these factors that must be considered in the evaluation step that follows.

In step 3 the evaluation of the goal is based on specified constraints and assumptions and anticipated consequences. In step 6 these factors plus the chosen goal must be considered when combinations of ideas are evaluated. In step 9 the detailed plan is checked against all of these factors plus the selected combination of ideas. After all the alternatives have been evaluated, the best one is selected. In step 12 it is not just options that are evaluated, but the implemented plan that is judged against the goal and the chosen ideas. The selection made here is of the best future action that should be taken.

Schooling Focused on Decision Making

The judgment people bring to their decisions depends on many factors. Critical thinking skills are among the more important. Critical thinkers are able to objectify thought. They weigh, reconcile, and assess contradictory arguments and points of view through dialogue, discussion, and debate. They make assumptions and recognize the assumptions made by others. They make inferences and judge the truth or falsity of those made by others. They interpret statements and decide if the conclusions follow logically. They evaluate arguments and decide if the assumptions that were made are relevant and provide strong or weak support. They use deduction to determine if the logic involved in a statement is correct. And they demand evidence.

But there is more, much more to decision making than analysis and evaluation. As shown here, effective decision makers need to be able to visualize situations, ask appropriate questions, and get answers from a variety of sources in order to determine the actors, props, action, scene, cause, and consequences of a solution. They can distinguish symptoms from problems and identify the problems that must be considered. They can generate options, use techniques such as brainstorming, synectics, and lateral thinking, and can synthesize ideas. They can specify the constraints that apply to a situation, make assumptions, consider the consequences of each proposal, evaluate ideas, and select the goal, idea, plan, and future actions that are appropriate. Decision making requires many enabling skills.

A Worthy Focus

Decision makers play the roles of philosopher, scientist, designer, and builder. Schooling focused on decision making, the developmental and critical thinking skills that serve it, and the knowledge base that supports it, will allow students to learn these roles, to claim their capacity to think and their heritage as human beings. ☐

1. National Commission on Excellence in Education, *A Nation at Risk* (Washington, D.C.: U.S. Department of Education, 1983), 21.

2. Robert Glaser, "Education and Thinking: The Role of Knowledge," *American Psychologist* 39 (February 1984): 93-104.

3. National Education Association, *An Open Letter to America on Schools, Students, and Tomorrow* (Washington, D.C.: NEA, 1984), 3.

4. C. E. Wales and A. H. Nardi, *Successful Decision-Making* (Morgantown: West Virginia University Center for Guided Design, 1984).

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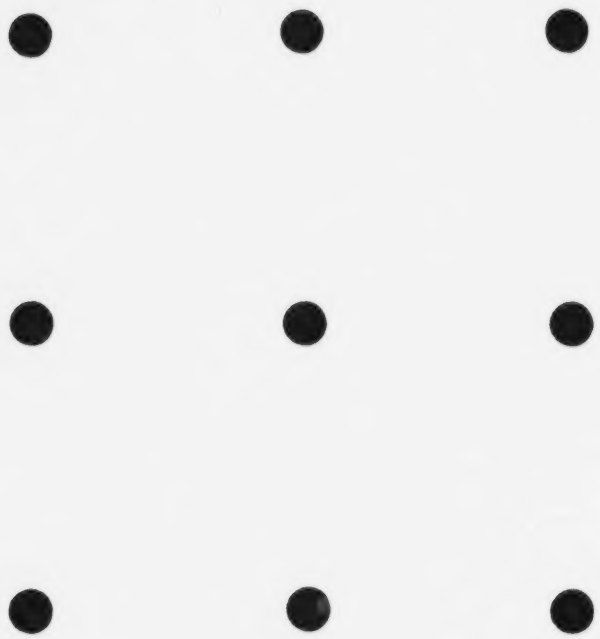
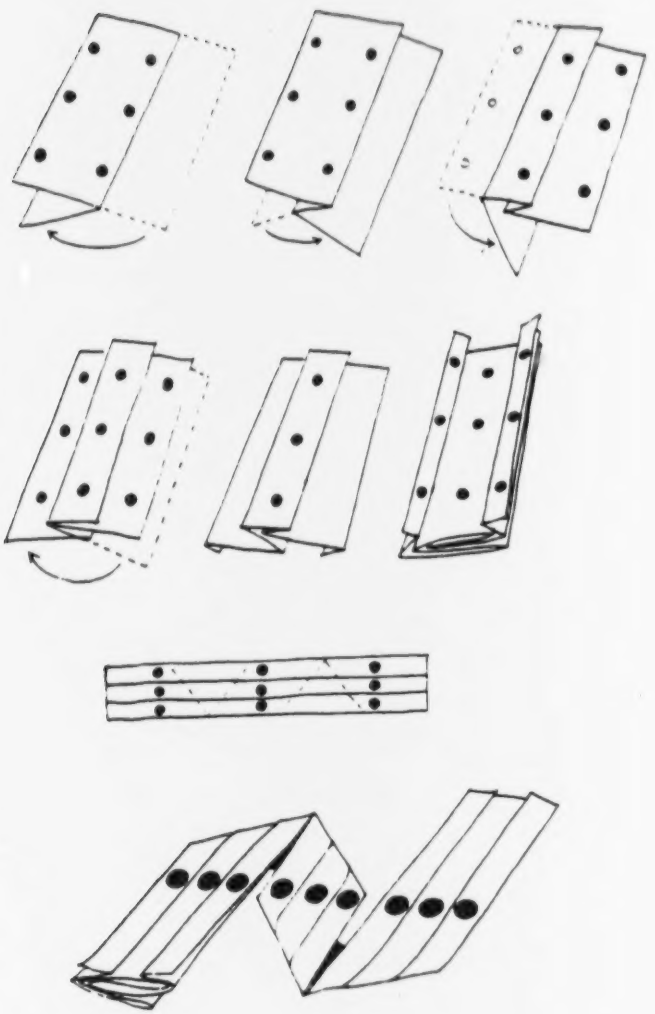


Make four (4) lines connecting all the dots
without taking your pencil off the paper.

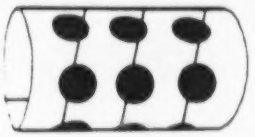
CONCEPTUAL BLOCKBUSTING

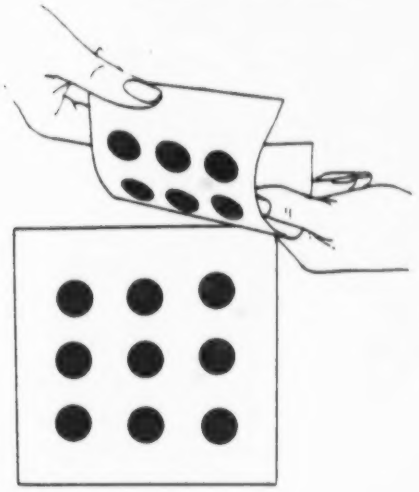
JAMES L. ADAMS

ANOTHER WAY OUT OF THE BOX



DEPARTURES FROM THE 2-DIMENSIONAL FORMAT





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"OTHER" WAYS OUT OF THE BOX

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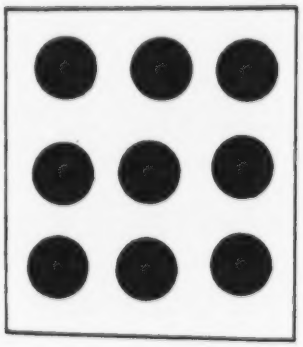


PROBLEM SOLVING

There are three ways to get to the top of a tree:

(1) climb it;

(2) sit on an acorn; or

(3) make friends with a big bird.

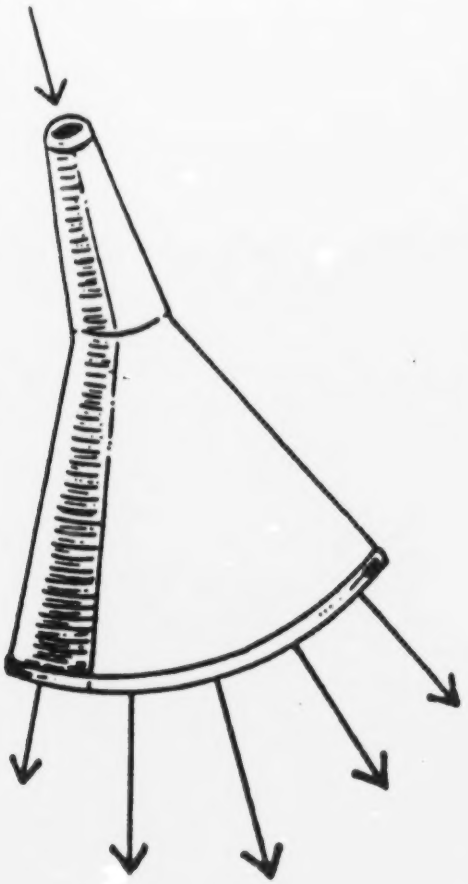
Robert Maidment

"FUNNEL THINKING"

IN WHAT WAYS MIGHT I? (IWWMI)

IWWMI?

IDEA-FINDING



OUT-POURING OF IDEAS

"It is the imaginative use of knowledge that is essential for actual creative productivity."

— Sidney J. Parnes

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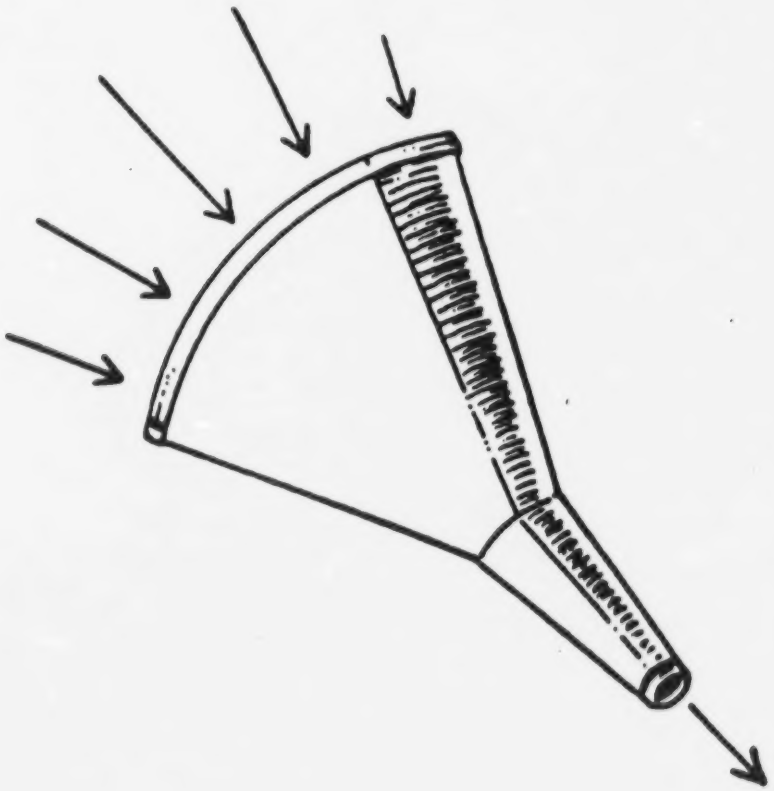
"FUNNEL THINKING"

GIVEN ALTERNATIVES, WHICH IS BEST? (GAWIB?)



GAWIB?

SOLUTION-FINDING

NARROWING DOWN
MAKING A CHOICE

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by Bob Eberle

LEAD-INS TO PROMOTE PROBLEM SOLVING

I'm stuck on . . .

The best way to think about this . . .

I conclude . . .

I'm lost with . . .

I understand, but . . .

I'm concerned about . . .

My problem is . . .

A question I have is . . .

Hall's library

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A problem well-stated
is a problem half-solved.

John Dewey

"MAN'S BODY IS FAULTY;
HIS MIND IS UNTRUSTWORTHY;
BUT HIS IMAGINATION
HAS MADE HIM
REMARKABLE."

JOHN MASEFIELD

PD/bj
11/88

BRAINSTORMING

WHY?

- TO GENERATE A LARGE NUMBER OF IDEAS
- TO OPEN PEOPLE UP TO SHARING IDEAS WITHOUT FEAR OF CRITICISM
- TO ENABLE PEOPLE TO BUILD ON EACH OTHERS' IDEAS

REMEMBER:

- QUANTITY IS DESIRED
- FREE-WHEELING IS WELCOMED
- ALL RESPONSES ARE ACCEPTED - NO CRITICISM
- HITCH-HIKING (OR PIGGYBACKING) IS ENCOURAGED

ENCOURAGING CREATIVITY THROUGH DIVERGENT PRODUCTION

PROVIDE EXPERIENCE TO WORK ON:

FLUENCY ..... THE ABILITY TO GENERATE MANY IDEAS BEFORE JUDGING

FLEXIBILITY ..... THE ABILITY TO BREAK HABITUAL THINKING - SEEING MANY ALTERNATIVES

ORIGINALITY ..... THE ABILITY TO CREATE NEW OR UNIQUE IDEAS

ELABORATION ..... THE ABILITY TO PLAN AND CARRY OUT IDEAS ADDING DETAILS

IDEA KILLER STATEMENTS

. WE DON'T HAVE TIME FOR THAT NOW! DON'T BOTHER ME!

. THAT'S A STUPID IDEA: YOU KNOW THAT'S IMPOSSIBLE!

. IF I HAD WANTED IT DONE ANY OTHER WAY, I WOULD HAVE SAID SO!

. I'VE HAD IT WITH YOU! JUST GET OUT OF HERE WITH YOUR SILLY IDEAS!

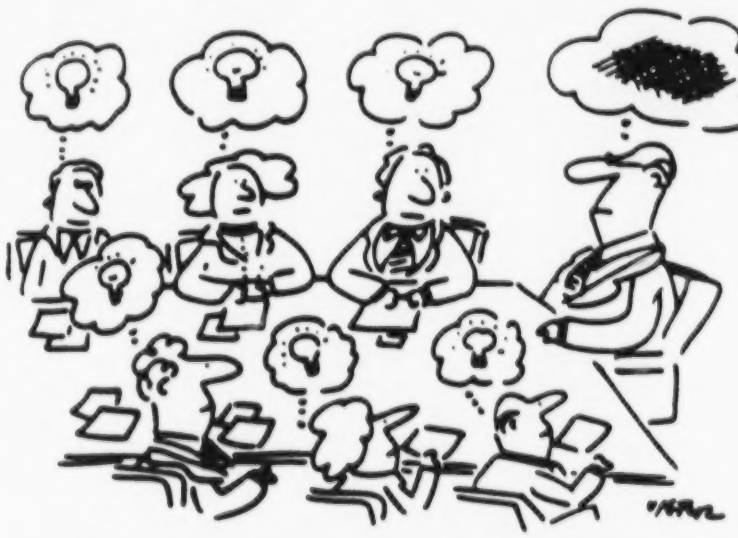
. THAT IDEA ISN'T NEW, YOU KNOW. IT WAS DISCOVERED YEARS AGO!

. YOU'RE NOT READY FOR THAT. IT JUST WON'T WORK, AND WOULD JUST BE A WASTE OF TIME!

. I DON'T CARE WHAT YOU THINK - DO IT LIKE I SAID!

* From Guiding the Gifted Child by James T. Webb, Ph.D., Elizabeth A. Meckstroth, M.S., and Stephanie S. Tolan, M.A.

VICTOR'S **FUNNY BUSINESS**



Six Ideas Absorbed by a Black Hole

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PARADOXES

A bank will lend you money only
if you prove you don't need it.

Be spontaneous!

BEST COPY AVAILABLE

"The only exercise some minds get is jumping to conclusions."

Pancy Torrance

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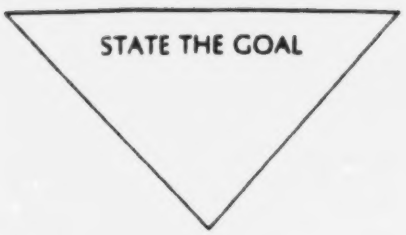
1. Identify Problems
ANALYSIS

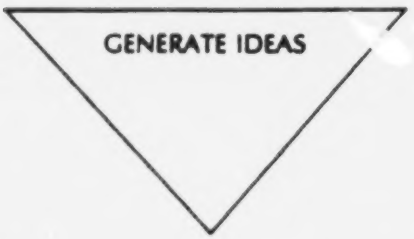
2. Create Options
SYNTHESIS



3. Select the Goal
EVALUATION

4. Identify Problems
ANALYSIS

5. Create Options
SYNTHESIS



6. Select Ideas
EVALUATION

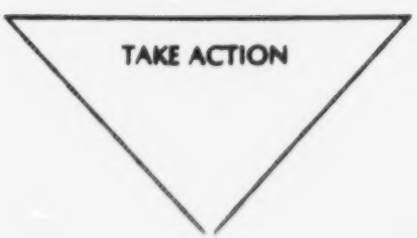
7. Identify Problems
ANALYSIS

8. Create Options
SYNTHESIS

9. Select a Plan
EVALUATION

10. Identify Problems
ANALYSIS

11. Create Options
SYNTHESIS



12. Select Future Actions
EVALUATION

"DECISIONS ARE EASY

IF YOU NO IT ALL."

by TRW

LIFE

REFERENCES

FUNNEL THINKING

In contrast, a second set of abilities used in Creative Problem-Solving places emphasis on ***convergent thinking.*** *The thinking processes involved are those of "narrowing down," as opposed to "opening up." Whereas divergent thinking has the requirement of producing a large number of ideas, convergent thinking has the requirement of selecting the best, correct, or most useful responses.*

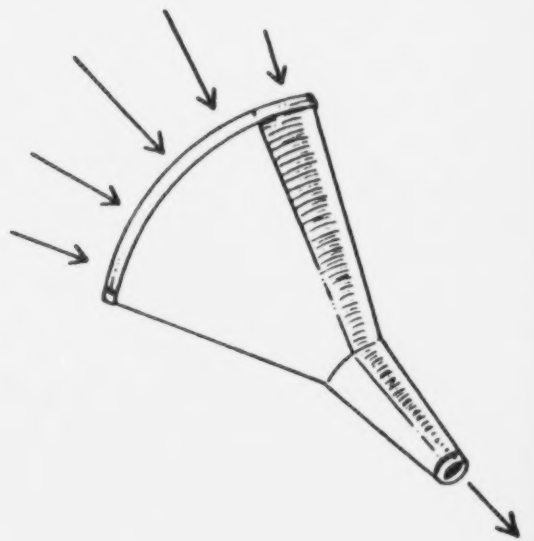
In arriving at the best, correct, or most useful responses, judgement and evaluation take place. After reviewing and evaluating the listed ideas, those having the greater promise for solving problems are selected. You now have the potential means for solving a problem or meeting a challenge.

For example, let's say that you wish to redecorate your bathroom. You have a choice of a) many different colors of paint, b) a combination of colors, and c) using wallpaper instead of paint. You now pose the question, "Given these choices, which is best?" To answer this question, you will need to establish some means of evaluating the alternatives available.

Judgement and evaluation call for the use of criteria. Criteria are the "yardsticks" used to measure the worth of ideas. With reference to the bathroom questions, we may wish to establish the following criteria: a) cost, b) ease of application, c) attractiveness, and d) durability.

Questions designed to bring about *convergent thinking* take into account the alternatives present. They also suggest that "measures of worth" are applied to the alternatives present. The evaluation of alternatives makes it possible to arrive at the best, correct, or most useful ideas. Solution-finding questions and the use of evaluative criteria make it possible to arrive at implementary solutions.

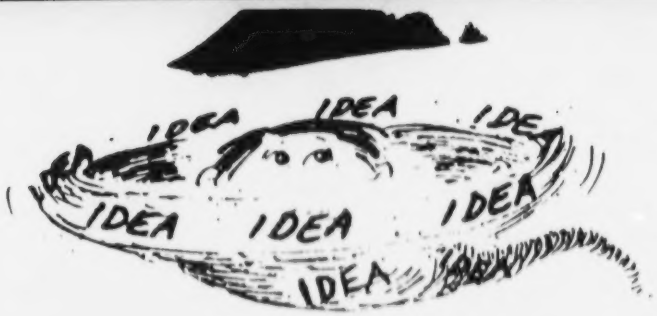
GIVEN ALTERNATIVES, WHICH IS BEST? (GAWIB?)



GAWIB?

SOLUTION-FINDING

**NARROWING DOWN
MAKING A CHOIC**



"The value of stored information lies in its future usefulness."

— J.P. Guilford

FUNNEL THINKING

Creative Problem-Solving calls for the use of two distinct ways of thinking. The first set of abilities, ***divergent thinking*** *skills, is put to use in a search for ideas. The objective is to produce a large number of ideas that meet the requirements of the problem. Going to our memory bank of stored information, we call out responses that have promise of usefulness. We also apply manipulative techniques to produce original, unique, useful ideas.*

Let's say that you wish to describe your feelings when you are faced with a knotty problem. You build up a long list of words from which a choice may be made when you pose the question, "What words might I use to describe my feelings?"

It is important to remember that *divergent thinking* is limited to the search for ideas. No attempt to judge or evaluate ideas should be made when you are conducting the search. The worth and selection of ideas is delayed till the appropriate time.

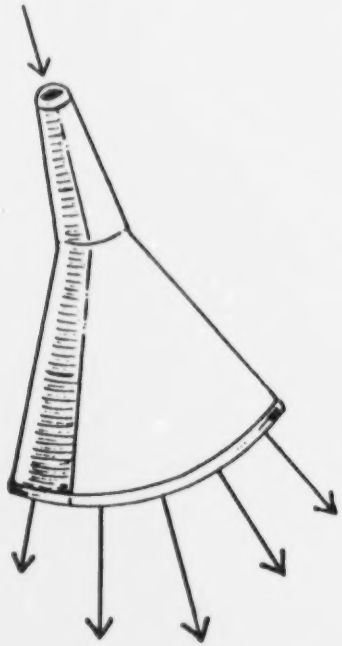
The Funnel Model on the following page "pictures" the *divergent thinking* process.

Questions designed to bring about the *divergent production* of ideas must be posed in ways that encourage, and allow for, the out-pouring of responses. The door to numerous possibilities is opened by framing the question, "In what ways might I?"

IN WHAT WAYS MIGHT I? (IWWMI)

IWWMI?

IDEA-FINDING



OUT-POURING OF IDEAS

HELP! in Solving Problems Creatively at Home and School
by Bob Eberle

"It is the imaginative use of knowledge that is essential for actual creative productivity."

— Sidney J. Parnes